

DISTRIBUTIONAL, ECOLOGICAL AND PHYTOGEOGRAPHICAL OBSERVATIONS ON THE FERNS OF SOUTH WEST AFRICA.

By E. A. C. L. E. SCHELPE.

(University of Cape Town.)

South West Africa is one of the arid and semi-arid regions of the world regarded by Christ (1910) as being almost without ferns. This impression can be regarded as accurate if one considers the territory as a whole, ranging from coastal desert, through vast areas of thorn savannah to occasional, shaded, watered kloofs on mountainsides. However, it became evident to the author on a collecting excursion to the territory in July, 1954, that the majority of species of the fern flora of the region occurred among rocky terrain of scattered rock outcrops or of mountain ranges. The minority of the ferns of South West Africa occur around such terrain in comparatively level ground e.g. *Ophioglossum polyphyllum*, or in seasonally wet areas, e.g. *Marsilea spp.* Another feature is the apparent absence of "fern allies" such as *Lycopodium*, *Selaginella*, *Isoetes* and *Equisetum* from the flora of South West Africa. Nevertheless, the possibility of the occurrence of *Isoetes* in seasonally wet areas in this territory cannot be excluded in view of the drought resistance of some South African species of the genus and the fact that the author's visit took place during the dry winter season.

A significant number of species of the ferns of South West Africa belong to genera with a noticeable proportion of xerophytic species, e.g. *Actiniopteris*, *Ceterach*, *Cheilanthes* and *Pellaea*. (Christ, 1910). The occurrence of these genera in xeric habitats in Africa has also been noted in Ethiopia (Schelpe, 1953) and in the Sudan (MacLeay, 1953). Species of *Pellaea* and *Cheilanthes* are also known to occur in xeric habitats in North America (Pickett, 1923; Pickett & Manuel, 1925) as well as species of *Notholaena* (Gams, 1938).

The rainfall of South West Africa is markedly seasonal in the northern and north-eastern parts of the territory (summer rainfall) and erratic though largely seasonal in winter in the southern parts. Active growth of the fern sporophytes takes place during the rainy season or subsequent to erratic rainy spells. As could be expected, the xerophytic ferns remain dormant during the dry seasons.

The purpose of this paper is, firstly, to record the available data on the known distribution of the South West African ferns to date, secondly, to

discuss their habitat range in the light of known facts on the autecology of xerophytic and other ferns, and, thirdly, to discuss the distribution of the ferns of this territory in relation to their distribution in Southern Africa and elsewhere.

The nomenclature used in this paper is according to the "Annotated Check-list of the Pteridophyta of Southern Africa" (Alston & Schelpe, 1952) except where more recent taxonomic work is cited. Specimens collected on the author's 1954 expedition to South West Africa are housed in the Bolus Herbarium, University of Cape Town and a second set is at the British Museum (Nat. Hist.), London.

DISTRIBUTION OF THE SOUTH WEST AFRICAN FERNS.

Although it is realised that the distribution ranges of some ferns in South West Africa may be extended by further collecting in the more remote areas of the territory, it seems likely that the distribution patterns of such species would not be altered seriously. During the author's travels in South West Africa, which were limited by time, an attempt was made to collect and record all the species observed in the areas visited. These observations have been supplemented with records from herbarium specimens prepared by earlier collectors represented in South African herbaria.

The areas investigated by the author were along a route from Goodhouse through Warmbad, Karasberg, Keetmanshoop, Windhoek, Okahandja, Usakos, "Ameib", Omaruru, Otjiwarongo, Waterberg, Otjiwarongo, Otavi, Grootfontein, Namutoni, Okakuejo, Outjo, Okahandja, Windhoek, Karasberg to Viools Drift.

The South West African ferns can be segregated into four convenient habitat groups.

1. Species occurring in rock crevices or around boulder bases on rock outcrops.
2. Species not essentially associated with a rocky environment, either in open semi-desert, or under the shade of bush.
3. Seasonally aquatic or seasonally hygrophilous species.
4. Floating aquatic species.

Since the majority of the ferns of South West Africa occur around more or less isolated mountains or ranges of hills, the positions of these hilly or mountainous areas considered in this paper are indicated in Fig. 1. The known distribution of the majority of the non-aquatic ferns are given in Table I.

DISTRIBUTION OF NON-AQUATIC SOUTH WEST AFRICAN FERNS.

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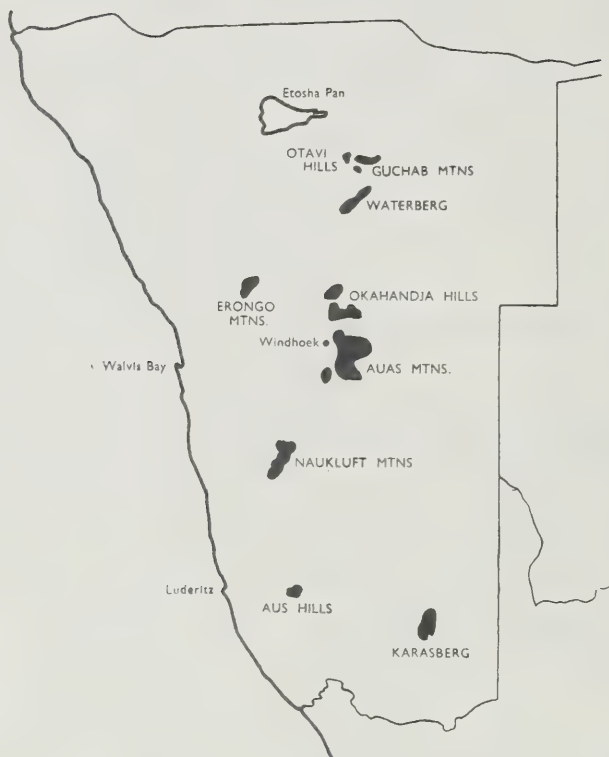


FIG. 1. Outline map of South West Africa showing the position of mountainous or hilly areas considered in this paper.

1. *Species occurring in rock crevices or around boulder bases on rock outcrops.*

(a) Low rainfall areas (less than 400 mm. average annual rainfall).

<i>Cheilanthes hirta</i>	<i>Pellaea deltoidea</i>
<i>Cheilanthes parviloba</i>	<i>Pellaea robusta</i>
<i>Notholaena eckloniana</i>	
<i>Notholaena rawsoni</i>	

(b) Higher rainfall areas (more than 400 mm. average annual rainfall).

<i>Adiantum caudatum</i>	<i>Pellaea goudotii</i>
<i>Cheilanthes multifida</i>	<i>Pellaea viridis</i>

- (c) Low and higher rainfall areas (less and more than 400 mm. average annual rainfall).

<i>Actiniopteris australis</i>	<i>Doryopteris concolor</i> var. <i>kirkii</i>
<i>Ceterach cordatum</i>	<i>Notholaena marlothii</i>
<i>Cheilanthes dinteri</i>	<i>Pellaea calomelanos</i>

As it is well known that the microclimates of small areas in hilly or mountainous regions are extremely variable, especially in predominantly seasonally arid areas, the preceding grouping of species can only be regarded as approximations of the general climate the species cited are probably able to endure.

2. *Species not essentially associated with a rocky environment.*

In the drier open parts of the territory only *Ophioglossum polyphyllum* (as construed by Pichi Sermolli, 1954) is known to occur in this type of habitat. The production of its fronds in this habitat appears to be subsequent to the occurrence of erratic but short rainy spells.

The perennially moist shaded habitats below the south-eastern cliffs of the Great Waterberg present a totally different picture. In this shaded forest habitat in an area with an annual average rainfall of nearly 520 mm., a few species were seen which were not recorded by the author nor any other collector, elsewhere in South West Africa. These species include *Microlepia speluncae*, *Dryopteris thelypteris* var. *squamigera* and *Dryopteris* sp. aff. *D. pseudoquentziana*.

3. *Seasonally aquatic or seasonally hygrophilous species.*

The specimens and data gathered by previous collectors in the higher rainfall areas in the northern and north-eastern parts of South West Africa during summer rainy seasons, indicate that species of *Marsilea* are not infrequent in this region. They appear to occur in areas which are either wet or inundated during summer rains. However, they are not evident during the dry winter season. Five species are known to occur in the northern and north-eastern parts of South West Africa, but the identity of three of the taxa is still in doubt.

Marsilea nubica

M. villifolia.

M. pubescens Dinter M.S. (? *M. macrocarpa* var.).

M. profundelaciniata Dinter M.S. (? *M. biloba* var.).

M. sp. aff. *M. subterranea*.

The absence of records of *Marsilea*s from the banks of the Etosha Pan was confirmed by the author in the course of observations along its southern limit between Namutoni and Okakuejo. It seems probable that the high salinity of the water near the banks of the pan would be beyond the tolerance of *Marsilea*s.

4. *Floating aquatic species.*

Azolla pinnata was collected by Miss Stephens in the Chobe swamps in the Caprivi Zipfel.

ECOLOGICAL ASPECTS OF FERN DISTRIBUTION IN SOUTH WEST AFRICA.

The alternation of generations in the Pteridophyta render it imperative that the separate tolerances of the gametophytic and sporophytic plants towards environmental conditions be considered when discussing the reproduction and persistence, respectively, of fern species in a certain habitat. Holttum (1938) summarised this view effectively: "The existence of fern plants is ultimately dependant on the occurrence, at least seasonally, of conditions in which the gametophyte generation can live and develop and the youngest stages of sporophyte growth become established."

Climatic factors.

Seasonally arid habitats abound in South West Africa. For a species to occur in such habitats it is essential that the sporophyte is able to endure drought and that the gametophyte either is also capable of drought resistance or capable of rapid development to the stage of producing a young drought resistant sporophyte during short and erratic, favourably moist conditions.

The capability of drought resistance of the rhizomes of sporophytes of the xerophytic species is not in question, considering the presence of large and extensive rhizome systems in the field. More significant is the ability of such rhizomes collected during the dry season to produce fronds on being transplanted into moist soil in culture. Hence, it would appear that the drought resistance of the gametophyte is a most important factor in the possible extension of fern communities in seasonally arid habitats, if such gametophytes are not capable of extremely rapid development during short favourably moist periods.

The limited work done on the drought resistance of prothalli of xerophytic ferns is relevant to the discussion at this stage. Pickett (1923) observed that the gametophytes of *Cheilanthes gracillima* survived nearly five months' air-drying. Pickett & Manuel (1925) found that 75 per cent of the gametophytes of *Pellaea atropurpurea* and *Pellaea glabella* in cultures survived air-drying of five months' duration. In these ferns it was also observed that the gametophytes and the young sporophytes survived drought equally well. The effect of light intensity on the drought resistance of fern prothalli was also studied by Pickett (1914) on gametophytes of *Camptosorus rhizophyllus*; the results indicated that the mature

prothalli could withstand "practically unlimited interrupted drought as found in nature, if not exposed to direct sunlight, producing sporophytes through fertilisation at the time of occasional showers."

In the drier areas of South West Africa the most obvious feature of the local distribution of ferns on rock outcrops is their occurrence, limited almost entirely to the south aspect slopes. This is significant in relation to Pickett's findings of greater drought resistance of the prothalli of *Camptosorus* in lower light intensities. Also, it can be expected that the more shaded south aspect habitats would remain moist for a longer period after rain as compared with the less shaded, warmer, north aspect slopes. Such moist conditions expected to continue for a comparatively longer period on south aspect slopes would allow the formation of young sporophytes, whether the gametophytes be apogamous or not.

Another adaptive feature of a xerophytic fern observed by Pickett (1923) in *Cheilanthes gracillima*, namely the retention of spores during the dry season and their release in the subsequent more moist season, has not yet been investigated among the xerophytic species of the Southern African ferns. Irregular germination of spores was observed by Pickett (1914) in *Camptosorus rhizophyllus*. Such a feature might be of importance if it occurs widely among xerophytic ferns in a habitat liable to receive short, erratic showers, occasionally followed by conditions dry enough to damage very young prothalli.

The two species of *Ophioglossum* (*O. polyphyllum*, *O. reticulatum*) known to occur in South West Africa are presumably also able to perennate through dry seasons by means of their rhizomes. Whether these populations have attained their present size and range largely by vegetative means or by a drought-resistant though long-lived gametophyte remains to be determined.

The confinement of the majority of the ferns of South West Africa to rocky outcrops on hills and mountain slopes requires some explanation. Vast areas of thorn savannah in which no ferns were seen, occur in this territory. Judging from the frequently loose sandy substratum in such vegetation it seems that this substratum is too unstable and too rapidly drained or dried to offer a firm and moist surface of sufficient duration for a polypodiaceous fern prothallus and subsequent sporophyte to become established.

Comprehensive temperature data are not yet available for South West Africa. However, it was gathered from local information that from the Waterberg northwards frosts do not occur and that in the vicinity of Windhoek frosts are infrequent. The vegetation on the mountains in the south of the territory, especially at higher altitudes, can be expected to

experience frost during the winter. The occurrence of tropical species such as *Microlepia speluncae*, in the Waterberg can be correlated partly with the non-occurrence of frost and partly with ample supplies of water in this locality. Conversely, the higher temperatures prevalent in the north-eastern parts of the territory might exclude certain species with more temperate requirements.

Edaphic factors

Gams (1938) listed some fern species with apparent edaphic preferences for soils ranging from acidic to alkaline in reaction. Since ferns occur on rock outcrops in South West Africa ranging from sandstone and granite to dolomite, data is given in Table II on the presence of various species occurring about outcrops of different rocks. As it is known that species of angiosperms and bryophytes exhibit different tolerances to chemical edaphic conditions in different rainfall areas, approximate data on the range of precipitation in which the species occur in South West Africa is given.

TABLE II.
SUBSTRATA OF SOME SOUTH WEST AFRICAN FERNS.

	Granite.	Micaceous Schist.	Sandstone.	Dolomite.	Approximate mean annual rainfall range of known habitats in South West Africa.
<i>Ceterach cordatum</i>	+	+	+		90—510 mm.
<i>Pellaea calomelanos</i>	+	+	+		150—510 mm.
<i>Cheilanthes dinteri</i>	+	+	+		150—470 mm.
<i>Notholaena marlothii</i>	+	+	+	+	350—530 mm.
<i>Actiniopteris australis</i>	+	+		+	350—530 mm.
<i>Adiantum caudatum</i>				+	± 530 mm.
<i>Cheilanthes hirta</i>	+				150—230 mm.
<i>Cheilanthes multifida</i>				+	± 530 mm.
<i>Cheilanthes parviloba</i>	+				± 350 mm.
<i>Doryopteris concolor</i> var. <i>kirkii</i> ..	+		+		230—510 mm.
<i>Notholaena eckloniana</i>	+				90—150 mm.
<i>Pellaea goudotii</i>			+		± 510 mm.
<i>Pellaea viridis</i>			+		500—510 mm.

It appears that *Actiniopteris australis* and *Notholaena marlothii* are able to tolerate both acid and alkaline substrata over a wide precipitation range. In South West Africa, *Adiantum caudatum* and *Cheilanthes multifida* have only been found on dolomite outcrops; however, the former has been seen growing as an epiphyte and forest-floor inhabitant in presumably

acid humus at the Victoria Falls and even the northern deltoid fronded form of *Cheilanthes multifida* (Schelpe, 1954) occurs on non-alkaline substrata in the Transvaal. The possibility of local ecotypes cannot be excluded, but it would seem that micro-climatic conditions are more important than edaphic factors in the limitation of the distribution of these two species. The rest of the species listed in Table II do not appear to tolerate substrata derived from dolomite, a view borne out by their known edaphic tolerances elsewhere in Southern Africa.

Factors affecting seasonally aquatic species.

The seasonally aquatic or seasonally hygrophilous Marsileas form an ecologically important group of the fern flora of South West Africa. Their ability to perennate through seasonally arid periods by virtue of their sporocarps has been recognised by Gams (1938) and others. Although it has been observed by the author that sporocarp formation can be induced by lowering the water level below ground level in cultures of *Marsilea macrocarpa*, data is lacking on the rapidity of formation of new sporophytes after extrusion of sporangia from the sporocarps at the onset of the rainy season.

PHYTOGEOGRAPHICAL ASPECTS OF FERN DISTRIBUTION
IN SOUTH WEST AFRICA.

From the floristic point of view, the most striking feature of the pteridophyte flora of South West Africa is the apparent absence of members of the Psilotales, Lycopodiales, Selaginellales, Isoetales, Equisetales and Marattiales, even from the occasional moist and subtropical localities in the north-eastern ranges. Considering the range of habitat exhibited by members of these groups elsewhere in Southern Africa, the only locality in South West Africa seen by the author where they could possibly be expected to occur is on the south-eastern slopes of the Great Waterberg. It would appear that members of these groups failed to reach such isolated favourable areas in their more recent migrations through the African continent. Nevertheless the possibility of the occurrence of seasonal drought resistant species of Isoetes in South West Africa cannot be excluded.

The distribution patterns in Southern Africa and elsewhere of ferns occurring in South West Africa fall into four more or less distinct groups.

1. Endemic species.
2. Species with a predominantly north-western Cape distribution.
3. Species with a predominantly southern African distribution.
4. Temperate and tropical outlier species.



FIG. 2. Distribution map of *Cheilanthes dinteri* (+) and *Notholaena marlothii* (●) in Southern Africa.

1. *Endemic species.*

The only two clearly distinct, endemic, non-aquatic species occurring in South West Africa are *Cheilanthes dinteri* (Schelpe 1954) and *Notholaena marlothii* (Fig. 2). It seems possible that these two species originated in this area from populations of *Cheilanthes multifida* and *Notholaena eckloniana*, respectively, which apparently now have a very restricted distribution range in South West Africa.

2. *Species with a predominantly north-western Cape distribution.*

This group includes *Notholaena rawsoni*, *Pellaea deltoidea* and *Pellaea robusta*. (Fig. 3). The limitation of the distribution of these three species to Namaqualand in the north-western Cape Province and to the southern parts of South West Africa poses a problem which is not easily explicable. They are undoubtedly ferns of arid terrain usually associated with rocky habitats. Superficially it would appear from mean monthly rainfall data

that the region occupied by these species is liable to a sparse winter rainfall. An examination of the rainfall data for Namaqualand shows that such means give a false picture as short and erratic rainy spells are liable to occur at any time of the year, though the majority of these rainy spells occur during the winter months.

3. *Species with a predominantly southern African distribution.*

Species included in this group are *Ceterach cordatum* (sens. lat.), *Cheilanthes parviloba* and *Notholaena eckloniana*. The specimens of *Ceterach cordatum* seen in South West Africa all belong to the more dissected variety *namaquensis* (P. & R.) which is widely distributed in the drier areas of the north-western, western and southern Cape Province.

The infrequent populations of *Cheilanthes parviloba* and *Notholaena eckloniana* in South West Africa seem to be much isolated outliers of predominantly southern Cape Province and eastern Southern African



FIG. 3. Distribution map of *Notholaena rawsonii* (+) and *Pellaea deltoidea* (●) in Southern Africa.

species respectively. If the increasing aridity of the central depression of Southern Africa during recent geological time is accepted, these outliers could be regarded as relics of far wider distribution patterns of these species. This view might be substantiated by the wide distribution of *Ceterach cordatum* and *Pellaea calomelanos* (Fig. 4) in Southern Africa, species which seem to have a wider tolerance towards extremes of temperature and water supply in the environment.



FIG. 4. Distribution map of *Pellaea calomelanos* in Southern Africa.

4. *Temperate and tropical outlier species.*

Among the seasonally aquatic ferns of South West Africa, at least *Marsilea nubica* falls into this group. The non-aquatic species classified in this section (see Fig. 5) form a large section of the fern flora of the territory and include the following:

Actiniopteris australis (sens. lat.).

Adiantum caudatum (sens. lat.).

Cheilanthes hirta.

Cheilanthes multifida.

Doryopteris concolor var. *kirkii*.

Dryopteris thelypteris var. *squamigera*.

Microlepia speluncae.

Ophioglossum reticulatum.

Pellaea calomelanos.

Pellaea goudotii.

Pellaea viridis (sens. lat.).

As observed in examples of the previous section these outliers could be regarded as relicts left in limited congenial habitats despite the supposed general drying of the southern parts of Africa.

The roughly reversed C-shaped distribution pattern of *Adiantum caudatum* and other ferns in Southern Africa appears to have no parallels among angiosperms in this region with the exception of the distribution pattern drawn by Weimarck (1940) for *Aristea angolensis*. In this case,



FIG. 5. Distribution map of *Doryopteris concolor* (●) and *Microlepia speluncae* (+) in Southern Africa.

Weimarck considers the populations of this *Aristea* in the Katanga as relics of an old connecting link between east and west African populations in this latitude. A similar view could be taken of the populations of *Adiantum caudatum* and *Microlepia speluncae* at the Victoria Falls.

It will be noted from Table III that *Cheilanthes multifida* is recorded from Southern and south-central Africa and also from north-eastern Africa. Comparable interrupted distribution patterns are exhibited by *Pyrrosia schimperiana* (Schelpe, 1952) and other ferns (MacLeay, 1953). Such distribution patterns could be held to indicate that the north-south continuity of older populations has been broken by adverse climatic changes developing at the middle of the distribution range.

The present distribution patterns of other members of this group seem to indicate that the South West African populations have been isolated from the main ramifications of the distribution of these species in Africa by the advent of locally unfavourable conditions over the territory as a whole. This is considered more probable than the recent arrival of widely dispersed propagules of these species in extremely limited favourable habitats from sporulating populations thousands of miles to the east and north.

In relation to this discussion it must be admitted that very little is known about fern distribution or climatic conditions prevailing in the northern parts of Bechuanaland. Only *Pellaea calomelanos* among the non-aquatic ferns has been recorded to the author's knowledge from the Kwebe Hills south of Lake Ngami. King (1942) records the widespread occurrence of inselberge in Bechuanaland. Such inselberge could possibly provide a habitat for xerophytic ferns and might provide "stepping stones" for the colonisation of rocky outcrops in South West Africa by eastern species in Southern Africa, assuming that the intervening distances of uncolonisable ground were less than the maximum distributional transport capacities of propagules from sporulating populations. However, in addition to incomplete distributional data, an inadequate knowledge of the sequence and nature of past climatic changes in the sub-continent prevent further substantiated argument on the possible past migrations and foci of spread of ferns in Southern Africa.

In this phytogeographical discussion reference can be made to Copeland's (1939) rather dogmatic comments on the place of origin of the Marsileaceae and the xerophilous and other ferns. He regards these as having had a southern origin apparently entirely on the dubious grounds of species concentrations, with little or no reference to the distribution of fossil ferns or to the availability of suitable habitats in the regions considered. From the evidence available at present, it seems to the author

that at least some of the genera of ferns occurring in Southern Africa including South West Africa are tropical outliers with tropical and not Antarctic areas of origin.

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SUMMARY.

The known distribution of ferns in South West Africa is summarised and discussed in relation to the climatic and edaphic aspects of the habitats occupied by these species. The relative drought resistance of the sporophyte and gametophyte in xerophytic ferns is considered as a limiting factor in their distribution. The phytogeography of the ferns of South West Africa is discussed in relation to the known distribution of these species in Southern Africa and elsewhere.

REFERENCES.

- ALSTON, A. H. G. (1934): Mr. John Gossweiler's plants from Angola and Portuguese Congo: Pteridophyta. *Journ. Bot.*, 1934, Suppl.
ALSTON, A. H. G. and SCHELPE, E. A. C. L. E. (1952): An annotated check-list of the Pteridophyta of Southern Africa. *Journ. S.Afr. Bot.*, **18**, 153—176.
CHRIST, H. (1910): *Der Geographie der Farne*. Jena.
CHRISTENSEN, C.:
(1906): *Index Filicum*. Hafniae.
(1932): The Pteridophyta of Madagascar. *Dansk. bot. Ark.*, **7**, 1—242.
COPELAND, E. B. (1939): Fern Evolution in Antarctica. *Philippine Journ. Sci.*, **70**, 157—188.
DEMARET, F. (1949): Les pteridophytes du Congo Belge et du Ruanda-Urundi. I. *Bull. Jard. bot. Etat, Brux.*, **19**, 251—269.
DIELS, L. (1902): *Die natürlichen Pflanzenfamilien; Polypodiaceae*. Leipzig.
GAMS, H. (1938): Ökologie der extratropischen Pteridophyten in *Manual of Pteridology*. The Hague.
HOLTUM, R. E. (1938): The ecology of tropical pteridophytes in *Manual of Pteridology*. The Hague.
KING, L. C. (1942): *South African Scenery*. Edinburgh.
MACLEAY, K. N. G. (1953): The ferns and fern allies of the Sudan. *Sudan Notes and Records*, **34**, 286—298.
PICI SERMOLLI, R. (1954): Adumbratio Florae Aethiopicae 3. Ophioglossaceae, Osmundaceae, Schizaeaceae. *Webbia*, **9**, 623—660.
PICKETT, F. L.:
(1914): Some ecological adaptations of certain fern prothallia—*Camptosorus rhizophyllus* Link, *Asplenium platyneuron* Oakes. *Amer. Journ. Bot.*, **1**, 477—498.
(1923): An ecological study of *Cheilanthes gracillima*. *Bull. Torrey bot. Cl.*, **50**, 329—338.

- PICKETT, F. L. and MANUEL, M. E. (1925): An ecological study of certain ferns, *Pellaea atropurpurea* (L.) Link and *Pellaea glabella* Mett. *Bull. Torrey bot. Cl.*, **53**, 1—5.
- SCHELPE, E. A. C. L. E.:
(1952): The genus *Pyrrosia* (Polypodiaceae) in Africa. *Journ. S.Afr. Bot.*, **18**, 123—143.
(1953): Ferns in Central Ethiopia. *Brit. Fern Gaz.*, **8**, 61—64.
(1954): The *Cheilanthes multifida* complex in Southern Africa. *Journ. S.Afr. Bot.*, **20**, 127—136.
- TARDIEU-BLOT, M. L.:
(1951): Ophioglossacées in *Flore de Madagascar et des Comores*. Paris.
(1953): Les Pteridophytes de l'Afrique intertropicale Française. *Mem. Inst. Franc. d'Afr. Noire*, 28.
- TRYON, R. M. (1942): A revision of the genus *Doryopteris*. *Contrib. Gray Herb.*, **143**, 3—80.
- WEIMARCK, H. (1940): Monograph of the genus *Aristea*. *Lunds Univ. Arsskr.*, N.F., Avd. 2, **36**.
- UNION OF SOUTH AFRICA: Department of Transport (1953): *Average Rainfall, South West Africa*. Pretoria.

TABLE III—Continued.

DATA ON THE DISTRIBUTION OF SOUTH WEST AFRICAN FERNS OUTSIDE SOUTH WEST AFRICA.

	Distribution in Southern Africa outside S.W. Africa.	Distribution in rest of Africa and African Islands.	Distribution outside Africa.
<i>Adiantum caudatum</i> (sens. lat) ..	Eastern.	Tropical Africa (Christensen, 1906). Moyen Congo (Tardieu Blot, 1953). Sudan (MacLeay, 1953).	Asia, New Hebrides (Christensen, 1906).
<i>Ophioglossum reticulatum</i>	Eastern.	Angola (Alston, 1934). Belgian Congo (Demaret, 1949). French Sudan, French Guinea, Ivory Coast, Ubangi Shari, Moyen Congo, Cameroons (Tardieu Blot, 1953). Madagascar, Comoro Is., Reunion, Mauritius, (Tardieu Blot, 1951). Sudan (MacLeay, 1953).	Tropical America, Samoa, Caroline Is. (Christensen, 1906).
<i>Pellaea viridis</i> (sens. lat)	Southern and Eastern.	Cape Verde, Abyssinia, Mascarene Is. (Christensen, 1906). East Africa (Diels, 1903). Sudan (MacLeay, 1953).	Arabia (Christensen, 1932).
<i>Pellaea goudotii</i>	Eastern.	Belgian Congo, Gaboon (Tardieu Blot, 1953). Madagascar, Comoro Is., Mascarene Is. (Christensen, 1932).	—
<i>Dryopteris thelypteris</i> var. <i>squamigera</i>	Southern and Eastern.	Angola, Belgian Congo, Cameroons (Tardieu Blot, 1953).	South India (Tardieu Blot, 1953).
<i>Microlepia speluncae</i>	Eastern.	Angola (Alston, 1934). French Guinea, Ivory Coast, Cameroons, Ubangi Shari, Moyen Congo, Gaboon (Tardieu Blot, 1953). Sudan (MacLeay, 1953). Madagascar (Christensen, 1932).	Pantropical (Tardieu Blot, 1953).